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Abstract

The case examines a project between a leading European retailer, Kaufhof Department Stores, and fashion merchandise manufacturer Gerry Weber utilizing RFID (Radio Frequency Identification). It shows how both players experienced significant cost, time, and inventory management improvements over the course of the 5-month project. These performance improvements occurred at both the warehouse level and in the stores. Lessons learned and the challenges of integration, standardization, and RFID price levels are also discussed.

Keywords: *RFID, fashion industry, supply chain*

1. Introduction

Recently, the trade press has been full of articles touting the value of RFID (Radio Frequency Identification) to the supply chain. Proponents suggest firms can use RFID "to

more accurately track assets and monitor key indicators, gain greater visibility into their operations, and make decisions based on real-time information" (Oracle, 2005) and "to tie together the physical flow of materials and the flow of information in the supply chain network and to operate with unprecedented levels of accurate, timely information" (SAP, 2005). RFID seems well suited to handle processes including receipt and issuing of goods, stock transfer, physical adjustments, and other transactions, as well as exception and resolution workflows, to helping retailers, which supports the idea that RFID is the missing link in supply chain management (Heinrich, 2005). However, the actual examination of the influences and impacts of RFID has been less well documented.

What is the impact of RFID on firms, their supply chain partners, the key processes, and performance? This paper examines an RFID project involving two leading European firms, department store chain 'Kaufhof' and fashion manufacturer 'Gerry Weber' utilizing the case study methodology (Yin, 1989). This method involved the collection of data through interviews, observation of and participation in the implementation, and review of internal source materials including memoranda and financial projections. The time frame allowed the research to investigate both the implementation and actual use of the RFID technology. This approach also highlights several crucial aspects for companies facing the RFID challenge.

2. RFID in Brief

RFID systems transfer data via radio signals and require no direct human contact. The core of RFID technology is the RFID transponder, also called the Smart Chip - a tiny computer chip with an antenna (e.g., Bhuptani, Moradpour, 2005; Shepard 2004). The RFID transponder can be integrated into a wafer thin paper tag or a reusable plastic hard tag. Consumer good suppliers attach these tags or labels to logistic units (palettes, cases, cartons, and hanger-good shipments) and, in some cases, to individual items.

With tagging of logistic units, palettes and cases can be tracked as they move through the value chain from manufacturers to distributors to the stores (e.g., Karkkainen, Holmstrom, 2005). The Serial Shipping Container Code (SSCC) is an internationally valid number for logistic units allowing the exact identification of transport units. With tags on items, each individual product can be identified and seamlessly traced along the entire supply chain, from manufacturer to distribution center, on to each store warehouse, and even to the sales floor and shelves (Kleist et al. 2004; KSA, 2005). Logistic units and individual items are identified by the Electronic Product Code (EPC). The EPC is stored on the RFID transponder. It consists of the European Article Number (EAN) and a nine-digit serial number.

An RFID reader is used to identify the number code stored on the RFID transponder. It emits an electro-magnetic signal, which the RFID transponder receives via its antenna. The maximum reading distance depends on the frequency range used for the data transmission. Various frequency ranges are available for RFID. For the consumer goods industry, two ranges are applicable: the high frequency range of 13.56 megahertz (MHz) which is readable up to 1.5 meters and the ultrahigh frequency range of 868 - 960 MHz readable up to 8 meters. The 13.56 MHz frequency has been typically used for RFID transponders on the individual item level (e.g., Garfinkel, Rosenberg, 2005). Transponders in this range are less prone to disruptions, in particular those due to the deflection of radio waves by metals. However, high-frequency waves can be read from a short distance only.

RFID reflects some earlier technologies such as bar coding in its identification of products and electronic data interchange (EDI) in its connection across organizational borders. It has the potential to offer substantially more data to partners on the movement and state of goods along the supply chain.

3. Case Setting

For years, the global fashion industry has been undergoing a process of pervasive change fueled by two major macroeconomic drivers: Evolving economic and political conditions have called for flexibility and innovation, and leaner economic times have reduced consumer buying power. As a result, discount retailers (e.g., WalMart, Aldi) and verticals, i.e., international fashion chains with their own production facilities (e.g., the GAP, Zara) have entered and won a remarkable share in the market. To meet these challenges, fashion manufacturers (e.g., Benetton) and retailers (e.g. WalMart) have turned to cutting-edge technology (e.g., Bruce, 1987; Camuffo et al., 2001; Vitale, 1987; Westerman, 2001).

As a consequence of changing market conditions and demanding customers, the entire fashion industry faces unprecedented challenges. Two prime examples of technology pioneers are Kaufhof Department Stores (Kaufhof) and fashion manufacturer Gerry Weber International AG (Gerry Weber). They have joined forces in exploiting the benefits of Radio Frequency Identification (RFID) technology along the fashion supply chain (METRO, 2005).

Kaufhof Department Store AG, a sales division of the METRO Group, is one of the leading department stores in Europe. The company celebrated its 125-year anniversary in 2004. As of October 2005, Kaufhof operates 134 stores (116 of them department stores) in more than 80 German cities, and 15 stores in 12 Belgian cities. Every day, more than two million customers visit Kaufhof's total of 1.5 million square meters of sales area in Germany and Belgium. The company employs a workforce of 27,000 and - in 2004 - generated €3.8 billion in sales, about 35% of those with fashion sales. Kaufhof's EBIT reached €56.1 million or 1.47%, which gives evidence to the scarce margins of department stores and underlines the cost pressures in fashion retailing.

Gerry Weber International AG is a German fashion and lifestyle company with worldwide operations founded in 1973. The Gerry Weber holding company comprises three brands: Gerry Weber, Taifun Collection, and Samoon Collection. The company counts around 800 shops with their shop-in-shop system. In the business year ending October 2005, Gerry Weber International AG earned about €400 million in sales, with a workforce of almost 1,700. With an EBIT margin of more than 8%, the results are above the industry average. The company's most important retail markets are Germany, England, Ireland, the Benelux countries, Austria, and Switzerland. Besides, Scandinavia, Eastern Europe, the Middle East and Far East, as well as Canada, are gaining in importance.

In the integrated supply chain, each new Gerry Weber collection has traveled a long way by the time it is introduced in Kaufhof department stores. From the Gerry Weber production facilities, the merchandise is delivered to the logistics service provider (Meyer & Meyer) and on to the Kaufhof distribution center, from where it is brought to the storage and display areas within each department store (see Figure 1).

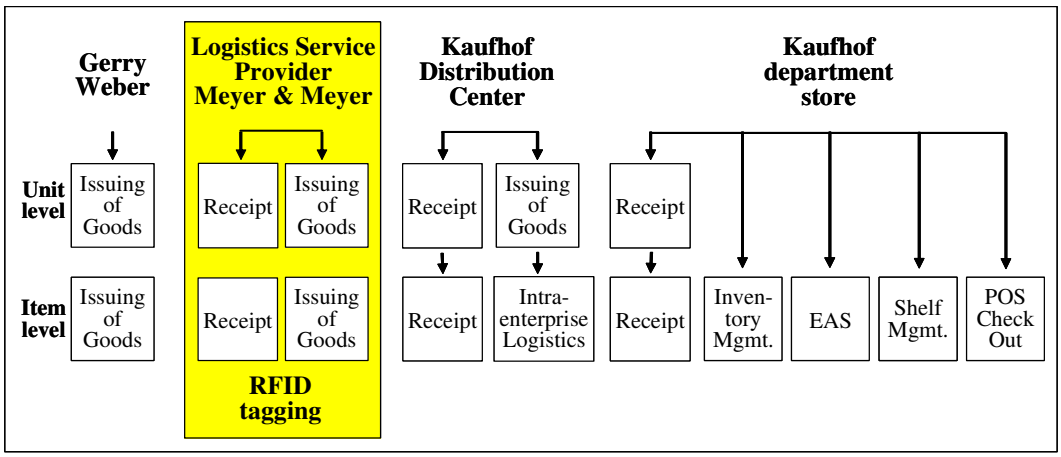

Figure 1: Supply Chain from Gerry Weber via Logistics Provider to Kaufhof

4. The Kaufhof / Gerry Weber RFID Project: Overview

The main objective of the RFID project undertaken by Kaufhof and Gerry Weber was to assess the degree to which RFID can accelerate and simplify workflows throughout the fashion supply chain in a real-world environment. A further goal was to analyze the use of RFID technology in anti-theft systems, a topic that has traditionally been of particular interest in fashion retailing (e.g., Bamfield 2004).

The project was launched on July 1, 2003 and ran through November 30, 2003. Besides the two main players, it involved various partners from IT industry and research. Gerry Weber's entire assortment sold at Kaufhof was considered for the project.

Kaufhof and Gerry Weber used the frequency range of 13.56 MHz for logistic units and items in 2003, as it was the only standard (ISO 18000 und 15693) available for both. The alternative, using two different frequency ranges for logistic units and items, would have called for two different sets of RFID readers and RFID transponders and thus increased the project costs substantially. Credit card sized RFID transponders and readers with a permissible capacity of 0.5 watts were used at a reading range of approximately 1.5 meters.

Several project specific hardware pieces were installed: Gerry Weber and the logistics service provider Meyer & Meyer each installed two RFID readers, both in the outgoing goods areas - one for stackable goods and one for hanger-goods. Further, at Gerry Weber headquarters, an RFID printer for generating tags was implemented. The Kaufhof Distribution Center was equipped with four RFID readers, both in the incoming and in the outgoing goods area one for stackable goods and one for hanger goods. In addition, a printer was set up to produce RFID transponders for logistic units that included the Serial Shipping Container Code. One Kaufhof Department Store was then provided with two escalator exits with anti-theft gates, two cash registers connected to the check-out system, one mobile reader, one RFID printer, and one Intelligent Clothes Rack. The second Kaufhof Department Store only required one shelf antenna, one cash register, one mobile reader, and one RFID printer.

5. The Kaufhof / Gerry Weber RFID Project: Results

5.1 Physics

The nature of materials marked the first physical restraint, as it influenced the reading quality. During the project, individual RFID transponders were placed in different materials, both water (included in the tests although less relevant for the fashion industry) and metal, and positioned in the reading field: An aluminum package (4 cm thick) was used, as well as a matchbox-sized package of paper clips (0.5 cm thick) and a coin. Water did not influence the reading procedure at the frequency of 13.56 MHz. Metal had some negative effect on the reading ranges, as it absorbed the radio waves. The coin did not disturb the reading process, indicating that metal buttons and zippers on fashion items would not pose a problem. However, any metal surface with the size of a matchbox required a distance of 0.5 cm for the RFID transponder to be read. For example, the reader could not register a RFID transponder directly affixed to a metal belt buckle. The reading quality deteriorated further with larger metal surfaces.

In addition, distance between the RFID transponders also turned out to be important for the reading rate. Initial readings for hanger goods were unsatisfactory. Problems arose with RFID transponders attached to garments made of thin material, hung close together. The effect was worsened when the products were fitted with slip covers and grouped into logistic units. Reading was disrupted when the angle between the transponder and antenna was close to 90 degrees. In most cases, a minimum distance of 0.5 centimeters was required between two RFID transponders. However, should a shipment pass through the reading portal with each RFID transponder at exactly the same height, even a minimum distance of between 1.5 and 3 centimeters was required to avoid interference. Having investigated the problems and made some adjustments to the set ups of the distribution center, the warehouses and the stores, the reading rate was at over 99% after the first four weeks of the project.

Another concern of tag proximity was the reading capacity when many tags passed the gate simultaneously. Registering data simultaneously and automatically are crucial for streamlining logistic processes. So, bulk readings, i.e., multiple and simultaneous RFID transponder readings, were conducted.

From the beginning most bulk readings worked without difficulty in the project, even the use of metal hangers posed no problem. Only when wider parts of the metal hangers, such as brackets on pants hangers, were in direct contact with RFID transponders, the reader was unable to register the data. These cases required set up adjustments to such direct contacts.

Finally, the speed at which the hanger-good shipments were transported through the gate turned out to be an issue: the more RFID transponders, the lower the speed. RFID readers simultaneously registered around 180 RFID transponders on hanger goods with the transponders remaining within the portal for approximately 20 seconds. With stackable goods in cartons, up to 60 transponders were registered within about three seconds.

5.2 Processes

The RFID project involved the entire process from tagging, packing, and shipping logistic units and items through distribution and warehousing on to display, sales, and theft prevention at the stores (see Figure 2).

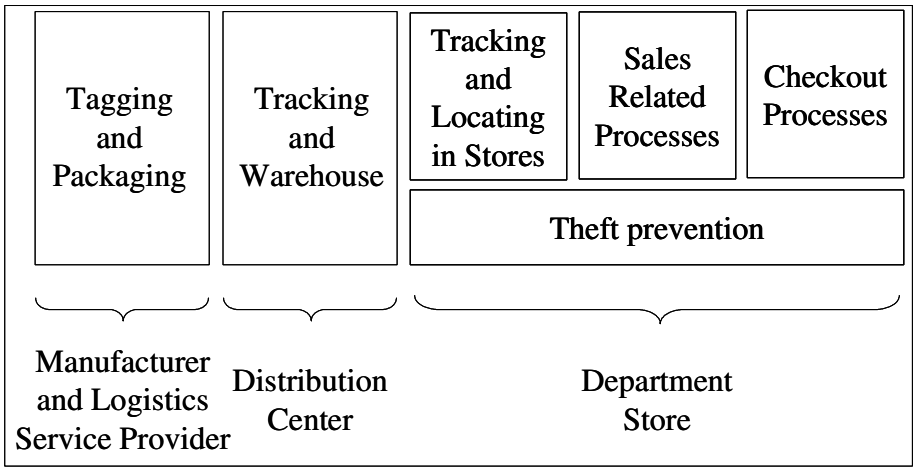

Figure 2: Key Processes along the Fashion Supply Chain

Tagging and Packaging: Gerry Weber generated the RFID transponders for items at their headquarters in Halle, Westfalen, Germany. The tags and merchandise were then sent to the logistics service provider. Staff at the logistics service provider carried out order-picking of the goods destined for the two Kaufhof test stores participating in the project and outfitted each item with an RFID transponder. The hanger-goods, such as dresses, pants, and jackets were then packed in slip covers, while the stackable goods (e.g., sweaters and t-shirts) were filled in cartons. RFID readers, installed in the outgoing goods area at the logistics service provider, scanned the packed merchandise before it was loaded on trucks for transport to a Kaufhof Distribution Center. Merchandise picked for an order was automatically matched with the shipment demanded and approved for transport, while the merchandise planning and control system registered the outgoing goods.

Tracking in Warehouses: Gerry Weber delivered orders to Kaufhof based on the increasingly popular cross-docking concept where employees in the distribution center were not required to repackage and sort goods for shipment to individual stores. Instead, the products were delivered in cartons or as hanger-goods as ordered by the stores, and transported without storage at the logistics service provider. The distribution center staff only equipped the Gerry Weber goods with Serial Shipping Container Code (SSCC) tags and brought them to the outgoing goods area.

At the warehouse entrance of Kaufhof's distribution center, Kaufhof employees utilized RFID readers to track the Gerry Weber merchandise as it came in. They registered the delivered products, distinguishing stackable and hanger goods. The data stored on the RFID transponders were read automatically for each individual product. For hanger-goods, the task of counting hangers was eliminated. This allowed quantity control of 100% of merchandise to take place automatically at the warehouses compared to previous spot checking of only 10%

Tracking and Locating in Stores: Kaufhof personnel utilized RFID technology for inventory and delivery tracking of the smaller logistic units. Hanger- and stackable-good shipments with RFID transponders arrived from the distribution center and passed through the incoming goods portals of the stores. Kaufhof staff scanned the RFID transponders on the Serial Shipping Container Code (SSCC) tags with a mobile RFID reader. The data were automatically entered into a central database and then compared to the values in the Kaufhof merchandise management system, a computer-aided information system to register and manage goods based on amount and value.

In the stores, Kaufhof employees used mobile RFID readers to register RFID transponders. They simply walked by the merchandise to gather the data; they no longer needed to scan each individual barcode. They could locate individual items and take inventory at the push of a button.

Sales-Related Processes: Item-level RFID also enhanced sales process options (see also Loebbecke 2004). 'Intelligent Clothes Racks' and 'Smart Shelves' allowed Kaufhof to gain additional intelligence about the customers' shopping and buying behaviors, which could then be used for further improving product and service offerings: *Intelligent Clothes Racks* were equipped with an RFID antenna. Each time a customer or employee removed a fashion item equipped with an RFID transponder from the rack, the movement was automatically entered into the merchandise management system. The moment the article was returned was also registered. The time that lapsed before a customer returned an item to the rack provided valuable information: If a customer put a blouse back on the clothes rack after five seconds, she possibly did not like the material. If five minutes went by, it is likely that the customer tried on the article. *Smart Shelves* offered similar functionalities for stacked goods.

Check-Out Processes: Selected cash registers were equipped with RFID readers and connected to the Kaufhof merchandise management system. In order to complete the checkout and payment process, staff merely placed the fashion goods onto the cash desk. All RFID transponders were simultaneously read and subsequently removed from the goods. With the total amount to be paid displayed at the cash register, customers then continued the check out with traditional payment procedures (credit card, cash, etc.).

Theft Prevention: The RFID readers in the test anti-theft gates registered the data on the RFID transponders. If the status 'not sold' was indicated, an alarm was triggered. However, data collection on theft prevention was rather limited due to two reasons: Different from normal settings: (1) Only 'escalator gates', not the much wider department store gates, could be covered by the limited width reading range, and (2) the alarm would also be triggered if customers carried items across department store levels, consequently passing escalator gates, without paying, i.e. without deactivating / eliminating the RFID transponder.

5.3 Price and Performance

In 2003, the key prices to be paid when implementing such a system were those related to the RFID transponders. With the number of logistic units and individual items to be tagged, achieving a lower price per RFID transponder was the definitive variable required to make a successful RFID business case. Kaufhof and Gerry Weber examined two RFID transponder pricing scenarios in detail, one with the use of reusable and one with disposable transponders:

Reusable RFID transponders allowed information to be rewritten and reused. At a 2003 unit price of €1 for reusable transponders, including common radio frequency and audio-magnetic theft protection systems, Kaufhof and Gerry Weber predicted a positive ROI after 1.5 years. The necessary processes of removing the transponders and recycling them for further use were the largest contribution to price.

Disposable RFID transponders allowed only for single use. At a unit price of €0.30 and €0.50 including theft protection in 2003, disposable transponders were not considered as part of a successful business case. Kaufhof and Gerry Weber predicted that the profitable usage of disposable transponders required a major drop in the price per transponder and the required set up processes. [Since then actual prices and price projections have varied widely based on transponder capabilities and on assumed RFID adoption].

The price for the entire RFID project also included prices for RFID antennas and readers. The readers needed to be placed at warehouses, at incoming goods portals at stores, at check-out points, and for theft prevention at exit points. Software needed to be developed and implemented that allowed for full integration of RFID related hardware with the existing merchandise management systems and other back-office systems. Training was also taken into account as adding to the price of the system.

At the beginning of the project, both partners jointly opted for reusable RFID transponders as the only viable business case in spite of necessary deactivation and redemption of RFID transponders and subsequent recycling. However, with prices for disposable RFID transponders dropping sharply right after the project, the insights from the project made Kaufhof and Gerry Weber shift to disposable transponders in their preparation of the subsequent roll-out.

At both Kaufhof and Gerry Weber, three indicators of positive performance impacts were observed. The time span of merchandise moving through the supply chain was shortened, the affiliated labor input reduced, and finally, data quality and subsequent service offerings enhanced:

In Gerry Weber's warehouse, the fashion provider experienced a variety of efficiencies in the warehouse processes. Traditionally, Gerry Weber performed a 100% quantity control on all shipments before they left the warehouse by manually scanning each barcode. With RFID, this quantity control and packaging took place up to ten times faster (faster quantity control and packaging). Counts of hanger-goods could be performed automatically. Stackable goods in cartons such as shirts and pants, which were not hand-counted without RFID, were automatically counted one by one with RFID readers installed on a conveyor belt (automatic and complete inventory monitoring). Altogether Gerry Weber could track the availability of merchandise in stores and in transit with reading costs per palette of below € 0.30.

In the Kaufhof warehouse, the application of RFID transponders on logistic units together with hanger-good conveyor systems equipped with RFID technology offered several major performance improvements. Receiving, monitoring, and sorting of merchandise became more accurate, faster, and more efficient. Concerning the monitoring of goods in the store, employees kept a constant and accurate overview of the location of goods in the store and in the warehouse.

At the store level, the use of RFID resulted in improved shelf management, enhanced ability to identify inventory and product movement within the store, and increased efficiency during the checkout process. Since the Gerry Weber products represented only a small percentage of the overall product mix available at Kaufhof, the results suggest that even greater improvements are likely if more products are RFID tagged.

6. Lessons Learned

6.1 Physics

RFID technology does function and hardware and software are being developed very quickly. Reading the code experiences some difficulties depending on the product itself and the delivery platform employed. For example, metals within, on, or around products create some reading challenges. Also tightly packed items make it difficult to accurately read individual tags. Future technological advances may offer solutions which react less sensitively to metal or liquids and introduce readers able to bridge larger reading distances. No single frequency fully suits the needs for both the distribution center applications and item-level in-store usages of RFID.

Processes

RFID simplifies, accelerates, and improves existing processes (e.g. taking inventory 'at the push of a button') and also allows for new value-creating ones. RFID driven process improvements require accompanying changes in store formats and arrangements as well as in equipment. New processes allow gathering enhanced intelligence about customer's shopping and buying behavior by tracking the flow of goods at Intelligent Clothes Racks and Smart Shelves.

Price and Performance

The price of RFID transponders is critical and must decrease to make large scale adoption economically viable. With major price drops - the single use, disposable RFID transponder prices dropped from €1 in July 2003 to €0.07 for 868 MHz tags and to €0.12 including tag material and data printing for 13.56 MHz tags in October 2005 - large-scale implementations are predicted to deliver positive business cases.

Retail companies can realize cost-savings due to better management and monitoring of their inventories, raise efficiency, and offer better services to their customers and supply chain partners. In the warehouses, especially the increased data accuracy, reduced time for inventory tracking, and faster palette and case cross-docking speed up the processes and make warehousing more efficient. In the stores, in addition to inventory tracking and better customer offerings, fewer stock outs are possible even with reduced stock levels.

7. Challenges and Conclusions

Widespread adoption of RFID will require industry-specific changes in work processes to allow players to take complete advantage of the inventory, tracking, and security capabilities made available through the new technology (e.g., Threlkel, Kavan, 1999). Technical standards and interconnections will come onto the agenda as they did for EDI and Open EDI in the 1990s (e.g., Chwelos, Benbasat, Dexter, 2001; Dearing, 1990; Asif and Mandviwalla, 2005).

Also, on the path to industry-wide RFID roll-out, the Kaufhof and Gerry Weber RFID project clearly indicates three major information systems related challenges which also sound familiar to those who have been involved in large-scale EDI activities:

First, standardized, user-friendly equipment such as readers for shelves, clothes racks, and mobile data collection, must be available so that all partners along the supply chain can easily integrate the devices. Second, coordinated software components need to guarantee seamless alignment with existing user systems. Third, information management systems and filters must allow for sufficient analysis of the vast amount of additionally collected data.

Further, the challenges of the 'first-mover versus follower' choice (e.g., Nygaard-Andersen, Bjoern-Andersen, 1994) regarding infrastructure technologies such as EDI, seem to reappear with RFID. Early on, companies could take deliberate decisions for or against the RFID implementation and the accompanying required process changes. At a certain roll-out stage, late movers will be pushed to adopt RFID along the supply chain. At least on logistic units, RFID is likely to become a competitive necessity. The EDI story (among many others for instance Brousseau, 1994) showed us that being early on the learning curve helped a lot. Kaufhof and Gerry Weber claim the same with regard to RFID. Whether being a first mover will provide a sustainable advantage in the RFID context remains to be seen.

Summing up, the case of Kaufhof and Gerry Weber suggests that any firm evaluating or implementing RFID must examine whether

- RFID physics are appropriate for the context,
- inventory management, data accuracy, tracking, and security are areas in which performance improvements and enhancements are sought,
- equipment and implementation prices can support a positive business case, and
- work processes can be adapted to the new capabilities.

Overall, the Kaufhof and Gerry Weber project shows positive and very promising tests of RFID viability under real-life conditions. While there continue to be technical, data management, and privacy issues for RFID, positive performance impacts on data collection and information management, at both the warehouse and store level offer a strong business case for both retailers and suppliers.

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